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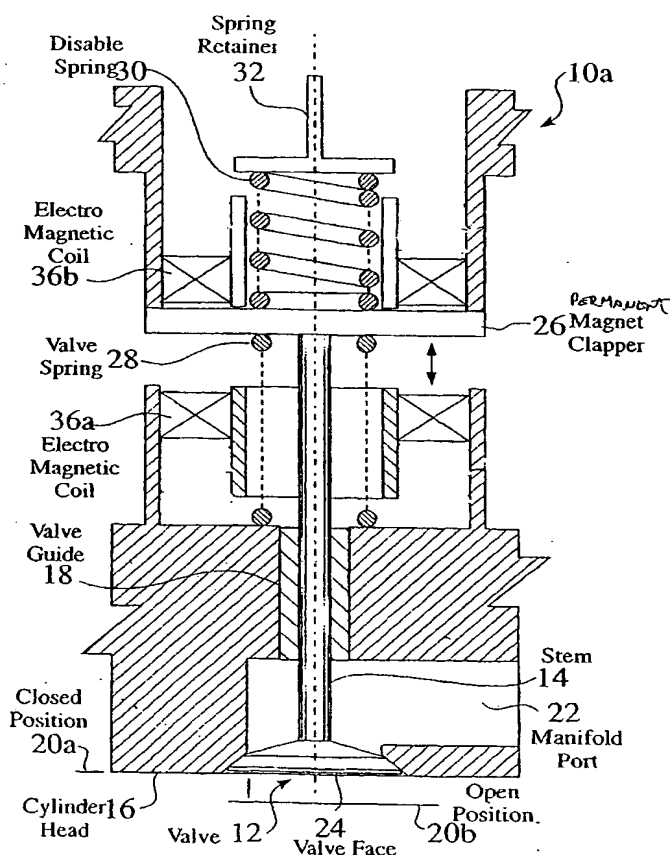
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[Continued on next page]

(54) Title: ELECTROMAGNETIC VALVE SYSTEM



(57) Abstract: Systems (10) are provided for electromagnetic actuation of a valve mechanism. A valve (12) is linearly moveable between a first closed position (20a) and a second open position (20b). A first spring (28) is compressed when the valve is in the first closed position, and a second valve spring (30) is compressed when the valve is in the second open position. An electromagnetic actuation assembly (36a, 36b) and a permanent magnet (26) is combined with the valve, such that the valve is latchable in either a closed or open position, and is readily movable between positions through application of energy to the electromagnetic circuitry. The electromagnetic circuitry is controllable to increase or decrease the local magnetic flux, such as to promote movement of the valve, or to provide a soft landing of the valve at either end of movement. Some system embodiments provide energy recovery, feed back, and/or feed forward sensing and control.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : F01L 9/04; F16K 11/04, 31/08

US CL : 251/65, 129.15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 251/65, 129.01-129.22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
East- electromagnetic, permanent, spring, first and second (spring), solenoid

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,647,311 A (Liang et al) 15 July 1997 (07.15.1997), fig. 4, whole document	23-26,28-33,35,37-39
Y		34, 36,40-41
Y	US 5,199,392 A (Kreuter et al) 06 April 1993 (06.04.1993), whole document	34, 36, 40-41
Y	US 5,494,219 A (Maley et al) 27 February 1996 (27.02.1996), whole document	34
A	US 5,769,043 A (Nitkiewicz) 23 June 1998 (23.06.1998), whole document	1
X	US 5,692,463 A (Liang et al) 02 December 1997 (02.12.1997), fig. 1-3, whole document	23-26,28-33,35-37
Y		34,36,40-41
A	US 5,074,259 A (Pusic) 24 December 1991 (24. 12.1991), whole document	1
A	US 6,199,587 B1 (Shlomi et al) 13 March 2001 (12 .03.2001), whole document	1

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☐ See patent family annex.

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"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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